APPENDIX B
ROADS, UTILITY CORRIDOR, AND PRIVATE LAND USE ANALYSIS SUMMARY

This appendix includes a description and analysis of roads and utility corridors and private land uses within stream buffer zones in the Prospect Creek watershed. The roads description and analysis includes road length stratified by ownership and type of road, the number of road-stream crossings by land ownership, road density and stream length with roads within stream buffer zones. Utility corridors, private land uses, and County Highway 471 are described in terms of stream length with utility corridors, private land uses or highway within stream buffer zones. Other road and utility corridor related issues are also discussed.

Road Length and Stream Crossings

Research shows that roads interact with surface and subsurface flow of water over hillslopes. This interaction may affect the hydrologic response of a watershed, including the timing and magnitude of the hydrograph. Wemple and Jones (2003) found that depending on the nature of storm events, watershed characteristics, and road segment attributes, storm flow response may be more rapid and have greater peaks because of the interaction roads have on hillslope flow.

Table B-1. Road Type and Location Summary Statistics

	First Degree Road Length* (miles)	Second Degree Road Length† (miles)	Third Degree Road Length§ (miles)	All roads (miles)
Total for Prospect Watershed				
	21.2	70.8	375.8	467.9
By Land Owner				
National Forest	15	59.6	348	422.5
Montana State	0	0	0	0
Private	6.2	11.2	27.8	45.2
By HUC 6 Watershed				
Clear	0.12	18.4	104	122.6
Cooper	0.18	0.41	17.9	18.4
Crow	0.10	16.6	39.4	56.1
Dry	1.06	10.7	32.2	43.9
Lower Prospect	11.9	11.5	139.9	163.3
Upper Prospect	7.8	4.4	28.9	41.2
Wilkes	0	8.8	13.5	22.3

* First Degree roads include main arterial and collector roads with 1-2 lanes, a high degree of user comfort, 35- 55 feet wide, and a non-native surface.
† Second Degree roads include local, collector or arterial single lane roads, are suitable for passenger cars or may require a high clearance vehicle, 15-25 feet wide, and may have native or non-native surface.
§ Third Degree roads include local and collector single lane roads, require a high clearance vehicle, may or may not be drivable, may be closed to public access (i.e. private roads), are 5-15 feet wide, have a native surface and limited to no traffic use.

Based on GIS data provided by the Lolo National Forest, approximately 468 miles of road and 307 stream crossings exist in the Prospect Creek watershed today (**Tables B-1 and B-2**). "Jammer" roads and skid trails are not included as roads on the GIS layer, and are therefore not included in the summary statistics values provided below. Among the parameters evaluated was road density (length of road per area of land). Road density provides a metric for the degree of "roadedness" or development in a watershed and has been linked to a watersheds ability to support fish populations. The location of roads within stream buffers was also evaluated. Roads in close proximity to streams can deliver road sediment to the channel network and impact vegetation and recruitment of woody debris.

Table B-2. Stream Crossing Location Summary Statistics

HUC 6 Name	Total Stream Crossings	National Forest Land	Montana State Land	Private Land
Clear	76	60	0	16
Cooper	16	16	0	0
Crow	32	32	0	0
Dry	23	14	0	9
Lower Prospect	114	97	0	17
Upper Prospect	29	25	0	4
Wilkes	17	15	0	2
Total	**307**	**259**	**0**	**48**

Road Density

Road density for the Prospect Creek watershed and its tributary watersheds were evaluated **(Table B-3)**.

Table B-3. Road and Stream Length and Density Summary Statistics*

HUC 6 Name	HUC 6 Area (miles2)	Road Length (miles)	Road Density (mi/mi2)	Stream Length (miles)	Stream Density (mi/mi2)
Clear	28.6	122.6	4.3	51.6	1.8
Cooper	15.8	18.4	1.2	78.7	5.0
Crow	14.8	56.1	3.8	32.2	2.2
Dry	35.8	43.9	1.2	28.6	0.8
Lower Prospect	40.3	163.3	4.1	84.7	2.1
Upper Prospect	29.6	41.2	1.4	61.2	2.1
Wilkes	15.8	22.3	1.4	30.6	1.9
Total	**180.7**	**467.9**	**2.6**	**367.6**	**2.0**

*Statistics are based on GIS layers of the road and stream network and reported by HUC 6 watershed boundary.

The USDA Forest Service classified road density in examining the characteristics of aquatic/riparian ecosystems in the Columbia River Basin (CRB) (1996, **Table B-4**). Watersheds with greater than 4.7 mi/mi^2 have an "Extremely High" road density. "Very Low" road density is defined by 0.02 to 0.1 mi/mi^2.

The CRB study found that as road density in a watershed increases, the ability of the watershed to support strong populations of key salmonids is diminished. The effect is more pronounced when all land management types are considered, and less pronounced when only National Forest lands are considered. For all lands, about 8% of watersheds with "High" road density supported strong salmonids populations, whereas for National Forest lands, 22% of watersheds with "High" road density supported strong salmonids populations (**Figure B-3**).

Applying the CRB road density classification to GIS analysis of road density, the Prospect Creek watershed has "high" road density with 2.6 miles/mile^2 (**Table B-3**). Individual HUC 6 sub-watersheds also are in the "high" road density category, including Clear Creek (4.3 miles/mile^2), Crow Creek (3.8 miles/mile^2), and Lower Prospect Creek (4.1 miles/mile^2). Road density in the remaining HUC 6 sub-watersheds is "moderate".

Table B-4.Road density classification

Classification	Road Density (mi/mi2)
Extremely High	> 4.7
High	1.7 - 4.7
Moderate	0.7 - 1.7
Low	0.1 - 0.7
Very Low	0.02 - 0.1

Reference: USDA Forest Service, 1996

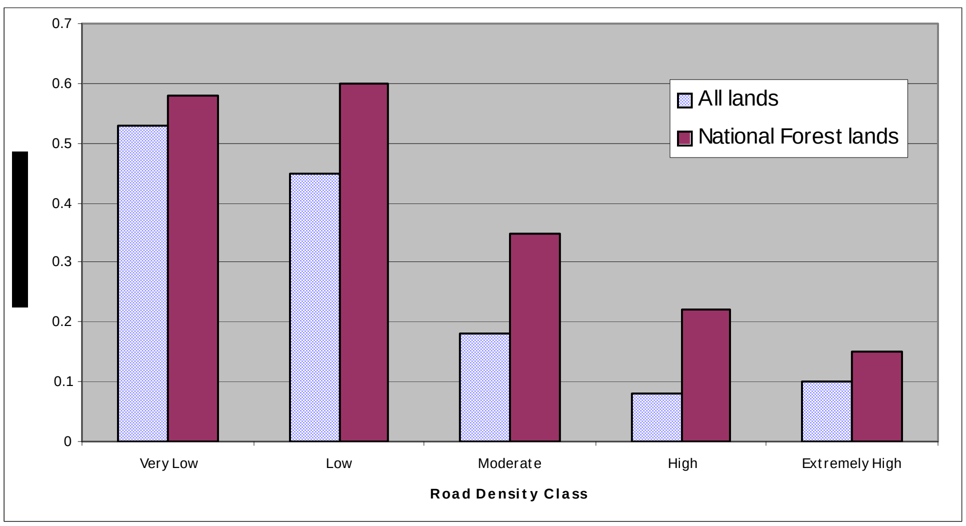

Figure B-1. Relationship between Road Density and Watershed Ability to Support Strong Populations of Key Salmonids
Adapted from USDA Forest Service, 1996

Stream density (length of stream/area of land) was also calculated. When comparing stream density to road density, Clear Creek, Crow Creek, Dry Creek, and Lower Prospect Creek HUC 6 watersheds have more length of road per square mile than length of stream (**Table B-3**).

Another way to examine stream or road density is to calculate and compare the average distance (Ad) between streams and between roads using the equation: **Ad = ½ (1/D)**, where D is density, the length of stream or road / area of land. In Clear Creek, for example, where Ds (stream density) is 1.8 mi/mi^2, Ad between streams (Ads) is 0.277 miles, and where Dr (road density) is 4.3 mi/mi^2, Ad between roads (Adr) is 0.116 miles:

Ads = ½ (1/1.8)	Adr = ½ (1/4.3)
= ½ (0.555)	= ½ (0.233)
= 0.277	= 0.116

This means that on average, a raindrop falling on the ground (assuming overland flow conditions) has more than twice as far to travel to get to a stream (1463 feet) as to a road (614 feet).

Road – Stream Proximity

Road density alone is not necessarily a good indicator of stream condition. The percent of stream length in close proximity to roads provides additional indicators of the potential impacts roads can have on streams. Those impacts may include alteration of riparian vegetation, sediment delivery, LWD recruitment, stream temperature, channel morphology, bank erosion, bank stability, sediment transport, and fish and aquatic habitat.

The 2000 Bull Trout baseline Section 7 Consultation study (Hendrickson, 2000) examined road-stream relationships using spatial analysis of GIS data including road and stream layers. One of the parameters evaluated by Hendrickson (2000) was the length of stream with roads within 125' and 300' (perpendicular distance). To characterize potential impacts of roads in the Prospect Creek watershed, a similar spatial analysis was conducted to evaluate the length of stream with utility lines within 125' and 300'.

The 300' buffer is based on a review of a large body of research on sediment delivery distances (Belt, et al. 1992). The review concluded that sediment within 300' of a water body has the potential to be delivered to the water body despite the presence of vegetation buffers. Roads are a source of sediment, and when constructed in riparian areas their proximity to a water body increases the likelihood of that sediment being delivered to the water body. Additionally, roads within 300' of a stream generally hinder the attainment of the INFISH Riparian Management Objective, RMO, which partially delineates the Riparian Habitat Conservation Area (RHCA) with a 300' buffer from perennial, fish-bearing streams (INFISH,1995).

The 125' buffer is used based on the average maximum height of the tree species most commonly found in riparian areas on the Lolo National Forest. Potential large woody debris recruitment is considered in terms of site potential tree height. In the region of the Lolo National Forest, mature trees within 125' of a stream have the potential of falling into the stream, and thus being recruited as large woody debris. Roads within 125' of streams preclude the growth of trees within the road template (often from top of cut slope to toe of the fill slope), decreasing the density of trees in the riparian area, and thus precluding the number of mature trees available for large woody debris recruitment. Clearing of riparian vegetation in these areas may also impact stream shading, stream temperature, bank erosion, and sediment delivery. The roads themselves may be a source of sediment, and when constructed in riparian areas their proximity to a water body increases the likelihood of that sediment being delivered to the water body. Based on research conducted by Belt and others, sediment within 300 feet of a water body has the potential to be delivered to the water body despite the presence of vegetation buffers (Belt, et al 1992). Additionally, roads within 300 feet of a stream generally hinder the attainment of the INFISH Riparian Management Objective (RMO) which partially delineates the Riparian Habitat Conservation Area (RHCA) with a 300 foot buffer from perennial, fish-bearing streams (INFISH, 1995).

In the Prospect Creek watershed, over 130 miles of road (29%) are located within 300 feet of streams and over 40 miles of road (9%) are located within 125’ of stream (**Table B-5**).

Stream length encroached upon by roads includes 113 miles of stream within 300 feet of a road **(Table B-6)**. This represents 31 percent of total stream length in the watershed. Of this, approximately 40 miles or 11 percent of the total stream length is within 125 feet of a road.

Four out of seven of the HUC 6 tributary watersheds to the Prospect Creek watershed have greater than 30% of their streams’ length encroached upon by roads within 300’ (**Table B-6**). Dry Creek and Cooper Creek have the greatest percent stream length within 300’ of road with 45 and 40 percents, respectively, while Clear, Crow and Cooper Creeks have the lowest with 23, 21, and 21 percents, respectively.

Percent of stream length within 125’ of roads is greatest in Dry Creek with 21% and Lower Prospect with 19%, followed by Clear Creek with 15%. Cooper Creek, Upper Prospect and Wilkes Creek have less than 10% of their stream lengths within 125’ of road. Eleven percent of Crow Creek stream length is within the site-potential tree height of road.

Table B-5. Road Lengths in Proximity to Streams

HUC 6 Name	Miles of road within 300' of streams	% HUC 6 road length within 300' of streams	Miles of road within 125' of streams	% HUC 6 road length within 125' streams
Clear	28.2	23	8.1	7
Cooper	7.4	40	2.3	12
Crow	11.6	21	4.0	7
Dry	19.7	45	6.5	15
Lower Prospect	49.9	31	17.3	11
Upper Prospect	12.3	30	4.0	10
Wilkes	4.7	21	1.3	6
Total	**133.8**	**29**	**43.6**	**9**

Table B-6. Stream Lengths in Proximity to Roads

HUC 6 Name	Miles of stream within 300' of roads	% HUC 6 stream length within 300' of roads	Miles of stream within 125' of roads	% HUC 6 stream length within 125' of roads
Clear	24.9	48	7.6	15
Cooper	6.2	8	2.2	3
Crow	10.0	31	3.5	11
Dry	17.7	62	5.9	21
Lower Prospect	40.7	48	15.7	19
Upper Prospect	10.1	17	3.6	6
Wilkes	3.5	11	1.2	4
Total	**113.1**	**31**	**39.7**	**11**

Utility Corridors and Private Land Uses

Utility corridors and other private land uses in close proximity to streams may have similar impacts on water quality as the road-related impact discussed above. Those impacts may include alteration of riparian vegetation, sediment delivery, LWD recruitment, stream temperature, channel morphology, bank erosion, bank stability, sediment transport, and fish and aquatic habitat. The same stream buffer distances used to analyze the length of stream with roads in close proximity were used to describe the length of stream with utility corridors and private land uses in close proximity.

Regular vegetation clearing in utility corridors that are within 125 feet of streams precludes establishment of mature trees in the riparian area, and thus restricts large woody debris recruitment to the stream. As discussed above for roads, clearing of riparian vegetation in these areas may also impact stream shading, stream temperature, bank erosion, and sediment delivery. Utility corridors and the roads used to access them may be a source of sediment, and when constructed in riparian areas their proximity (within 300 feet) to a water body increases the likelihood of that sediment being delivered to the water body despite the presence of vegetation buffers (Belt et al, 1992). Additionally, utility corridors including access roads within 300 feet of a stream generally hinder the attainment of the INFISH Riparian Management Objective (RMO) which partially delineates the Riparian Habitat Conservation Area (RHCA) with a 300 foot buffer from perennial, fish-bearing streams (INFISH, 1995).

Northwestern Energy, Bonneville Power Administration (BPA), and Yellowstone Pipeline (YPL) maintain utility corridors in the Prospect Creek watershed. The YPL route occurs in the valley bottom along the mainstem Prospect Creek upstream to Thompson Pass approximately 2.5 miles west of Twentyfour Mile Creek. The BPA route follows the valley bottom from Reach 1 upstream to the confluence with Crow Creek, at which point the transmission line enters the valley bottom of Crow Creek in close proximity to the channel. The Northwestern Energy utility corridor also traverses the Prospect Creek valley bottom upstream to Cooper Creek. At the confluence, it veers south and parallels the mainstem Cooper Gulch upstream to the watershed divide.

The length of stream with power lines and pipelines encroaching within 125 feet and 300 feet were evaluated using GIS buffer analysis. GIS layers of the power lines and pipelines (both original and re-routed sections) were used along with a GIS layer of the entire lengths of mainstems Prospect, Cooper and Crow creeks.

The length of stream with private land uses encroaching within 125 feet and 300 feet were also evaluated by aerial photo interpretation. Private land uses were categorized as residential development (residences and lawns), pasture, and timber management. Areas evaluated for private land uses included the lower 13.8 miles of Prospect Creek (up to Shamrock Gulch), the lower 2.1 miles of Dry Creek, and the lower 5.4 miles of Clear Creek.

Analysis results of stream length with utility corridors or private land uses within 125 feet and 300 feet buffers are presented in **Table B-7**.

Table B-7. Miles and Percent of Total Stream Length Within 125 ft and 300 ft of Utility Corridors and Private Land Uses

			Power Lines				YPL				Power Lines and YPL				Private Land Uses*			
Stream	**Total Length**	**Length Evaluated**	**125 ft**	**% of Total**	**300 ft**	**% of Total**	**125 ft**	**% of Total**	**300 ft**	**% of Total**	**125 ft**	**% of Total**	**300 ft**	**% of Total**	**125 ft**	**% of Total**	**300 ft**	**% of Total**
Prospect Creek[~]																		
	24.2	24.2	1.7	7%	4.4	18%	4.4	18%	10.1	42%	5.4	22%	11.3	47%	1.1	5%	3	12%
Clear Creek[@]																		
	12.1	5.4	--	--	--	--	--	--	--	--	--	--	--	--	1	8%	1.2	10%
Cooper Creek[#]																		
	6.6	6.6	1.3	20%	3.1	47%	0.1	2%	0.1	2%	1.4	21%	3.1	47%	--	--	--	--
Crow Creek[^]																		
	1.4	1.4	0.5	36%	0.7	50%	0.2	14%	0.3	21%	0.6	43%	0.7	50%	--	--	--	--
Dry Creek[&]																		
	4.2	2.1	--	--	--	--	--	--	--	--	--	--	--	--	0.3	7%	0.5	12%

*Residences, Lawns, Timber Management, or Pasture

Stream Length Evaluated:

~ Power and Pipe Lines: 24.2 miles from Clark Fork to headwaters; Private: 13.8 miles from Clark Fork to Shamrock Gulch

@ Private: lower 5.4 miles upstream from Prospect Creek

Power and Pipe Lines: 6.6 miles from Prospect Creek to headwaters

^ Power and Pipe Lines: 1.4 miles from Prospect Creek to East-West Fork confluence

& Private: lower 2.1 miles upstream from Prospect Creek

As noted for the 125 foot and 300 foot buffers, approximately 5.4 miles (22%) and 11.3 miles (47%) of the total mainstem stream length (24.2 miles) are associated with utility corridors, respectively. Private land uses are associated with 1.1 miles (5%) and 3.0 miles (12%) of the 125 foot and 300 foot buffers of the length of Prospect Creek mainstem.

The length of Clear Creek evaluated for private land uses is 5.4 miles or 45 % of the length of Clear Creek (12.1 miles). Of the 5.4 miles evaluated, 1.0 mile (19%) and 1.2 miles (22%) of Clear Creek have private land uses within the 125 foot and 300 foot buffers, respectively. These private land uses represent 8% and 10% of the entire length of Clear Creek.

Of the total length of mainstem Cooper Creek (6.6 miles), power lines encroach upon 1.4 miles (21%) and 3.1 miles (47%) of stream within the 125 foot and 300 foot buffers respectively.

For Crow Creek mainstem (1.4 miles), power lines and pipeline encroach upon 0.6 miles (43%) and 0.7 miles (50%) of stream within the 125 foot and 300 foot buffers respectively.

The length of Dry Creek evaluated for private land uses is 2.1 miles or 50% of the length of Dry Creek (4.2 miles). Of the 2.1 miles evaluated, 0.3 miles (14%) and 0.5 miles (24%) of Dry Creek have private land uses within the 125 foot and 300 foot buffers, respectively. These private land uses represent 7% and 12% of the entire length of Dry Creek.

County Highway No. 471

A similar encroachment analysis to evaluate the impacts of County Highway No. 471 on the mainstem Prospect Creek was completed. As noted in **Table B-8** for the 125 foot and 300 foot buffers, approximately 1.9 miles (10.1%) and 6.7 miles (35.5%) of the total mainstem stream length are associated with the County Highway No. 471, respectively (**Table B-8**). The county highway in close proximity to streams has similar impacts on water quality as those discusses for roads and utility corridors in the sections above. Those impacts may include alteration of riparian vegetation, sediment delivery, LWD recruitment, stream temperature, channel morphology, bank erosion, bank stability, sediment transport, and fish and aquatic habitat.

Table B-8. Miles of Stream Length Within 125 ft and 300 ft of County Highway No. 471

125 ft	300 ft
1.9 miles	6.7 miles

Other Road- and Utility Corridor-Related Issues

In some areas, multiple land uses occur within the riparian buffer zones.

Additional road- and utility-related issues affecting water quality in Prospect Creek include are discussed in more detail in other sections of this document. **Appendix H** presents a more detailed stream crossing analysis in terms of culvert sizing and failure risk and in terms of fish passage capabilities. Stream crossing analysis results are also summarized in the Phase I assessment document (RDG, 2004). Bridge structures crossing Prospect Creek were reviewed in

2003. Results of the bridge review are presented in the Phase I assessment document (RDG 2004). Temperature loading results are presented in **Appendix I**.

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